Center Innovation Fund: ARC CIF

Biologically Inspired Radiation-Reflecting Ablator (BIRRA) for Enabling Entry Descent and Landing Missions to Gas Giant Planets or Radiation-Intensive Environments

Completed Technology Project (2011 - 2012)

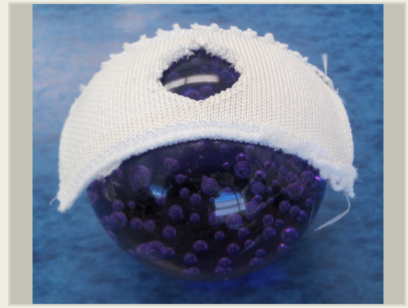
Project Introduction

We propose to develop and demonstrate a radiationreflecting thermal protection system (TPS) to enable missions where radiative heating during atmospheric entry is significant, such as into a giant gas planet. Because layered or ordered structures can be difficult to fabricate, we will utilize a naturally occurring ordered material, diatoms. Diatoms are unicellular algae that grow siliceous structures.

Tunable reflectors (for different planetary environments) can be constructed based on photonic structures, which are periodic arrangements of materials with contrasting dielectric properties. In such structures, internal reflections interfere destructively, blocking propagation of radiation into the material. Typically, this periodicity must be on the order of the wavelength to be reflected, which for EDL applications could be hundreds of nanometers. Fabrication of such small structures is very expensive, when possible at all. Our approach involves incorporating ordered entities into a matrix to form a material that will reflect radiation. We will use naturally occurring inexpensive diatoms to produce materials with ordered structures. The amorphous silica cell walls of diatoms are lightweight structures with a complex architecture that contains a periodic arrangement of pores in the micrometer to nm- range. Architecture of this complexity has not yet been achieved in materials science. Diatom pore arrangements are of the order of optical wavelengths; thus the cell walls act as photonic structures. The SiO_2 cells will be converted to high temperature materials without destroying their inherent pore structure. The converted diatoms (CD) will be randomly incorporated in a matrix such as phenolic or a phenolic-impregnated composite material. The random orientation will permit reflection from a wide range of angles. Reflecting even part of the radiation can make the difference in making a TPS capable for a demanding mission. It may also be possible to orient the entities to provide preferred directions of reflection.

Anticipated Benefits

The new material BIRRA will be of great interest to SMD for planetary missions and also to ARMD for earth entry missions where radiation is substantive. The approach is game changing in that it allows TPS material to be developed simply and inexpensively and thus enable missions where radiative heating is severe.



Sample of knitted ceramic fiber structure formed over a 4 cm radius sphere

Table of Contents

Biologically Inspired Radiation-Reflecting Ablator (BIRRA) for Enabling Entry Descent and Landing Missions to Gas Giant Planets or Radiation-Intensive Environments

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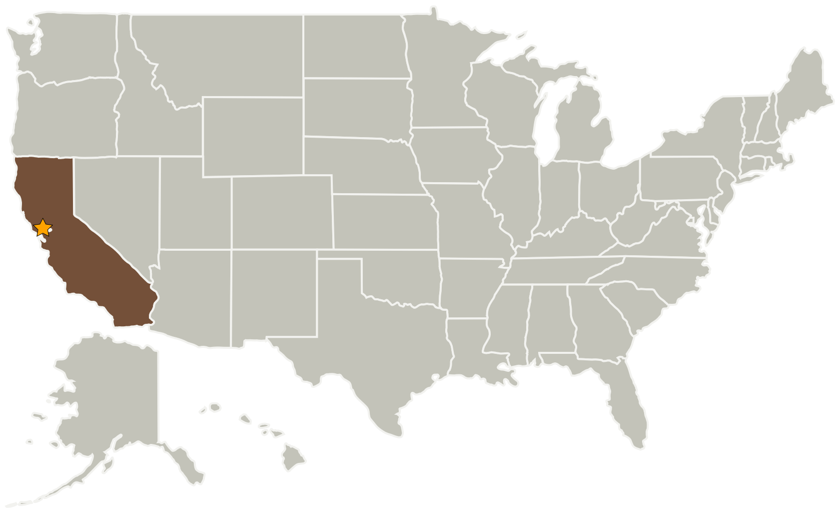
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Ames Research Center(ARC)	Lead Organization	NASA Center	Moffett Field, California
ERC Inc.	Supporting Organization	Industry	

Primary U.S. Work Locations
California

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Ames Research Center (ARC)

Responsible Program:

Center Innovation Fund: ARC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

Harry Partridge

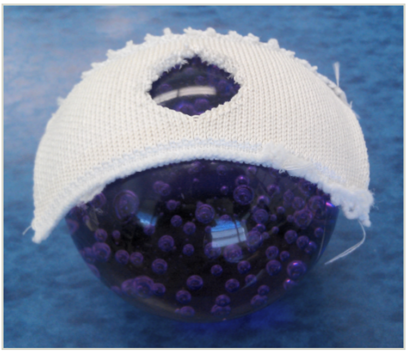
Project Manager:

Sylvia M Johnson

Principal Investigator:

Sylvia M Johnson

Images



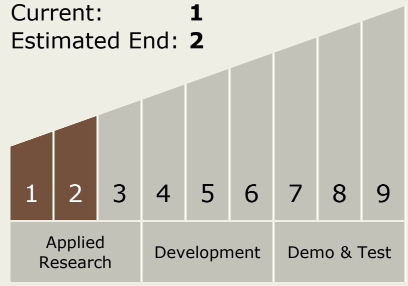
Knitted Fiber Structure
Sample of knitted ceramic fiber structure formed over a 4 cm radius sphere
(https://techport.nasa.gov/image/3031)

Stories

1676 Review (17536)
(https://techport.nasa.gov/file/8729)

Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **2**



Technology Areas

Primary:

- TX14 Thermal Management Systems
  - └ TX14.3 Thermal Protection Components and Systems
    - └ TX14.3.1 Thermal Protection Materials